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CRITICAL PARAMETERS AFFECTING THE MANAGEMENT AND ECONOMICS OF ALUMINA PRODUCTION*

Prepared by

Frank A. Lopez**

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** Works Manager, Ewarton Works, ALCAN Jamaica Company, Jamaica

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THE CHALLENGE

Since most bauxites contain 40 to 50 percent alumina and the alumina is extracted by the 90 year-old Bayer process, one could expect there to be a typical cost of alumina production, but this is not the case. There is no typical cost for alumina production.

The cash cost components for alumina production differ from plant-to-plant. Table I shows a comparative study of a number of existing Alumina plants of different sizes and locations. Bauxite costs range from $20 to $93 per tonne alumina produced, energy from $23 to $81 per tonne alumina, labour from $11 to $50 per tonne, caustic from $3 to $53 per tonne and the other cash costs from $3 to $36 per tonne.

If a plant could be built where all the cost components were at the minimum of the plants studied above, then the cash cost of alumina production would be only $60 per tonne. In contrast, if the plant had all the maximum costs, the alumina would have a cash cost of $313 per tonne. This wide range from $60 to $313 per tonne illustrates the contention that there are no typical costs for alumina production.

Alumina Plants operate to produce a raw material to feed Aluminium Smelters. At the start of 1985 the reported smelter operating capacity in the Western World was at 12.5 MTY

thus creating a demand for some 25 MTY of alumina. Current installed alumina plant capacity is approximately 34 MTY showing a large over supply (Table II). Cash reserves will obviously not allow for the stockpiling of this surplus, therefore, alumina plants will have to cut back on their operating levels, some suffer drastic cut backs and still others shut down completely. What are the critical parameters which will affect the management and economics of alumina production?

WHY DO COSTS DIFFER?

INVESTMENT The investment required for an alumina plant can be between $600 and $1700 per annual tonne of alumina produced, varying with the infrastructure, the plant capacity, location and process flow-sheet. The capital charge, which is the addition to the cash cost required to give a rate of return on the investment depends on the investment; on the discounted cash flow rate of return required; on the taxes paid on profits and on the annual escalation rate. Investments of $1000/annual tonne with 3 percent DCFRR and of $1500/annual tonne with 8 percent DCFRR could require capital charges in the overall range $70 to $190 per tonne of alumina produced. Although we will primarily talk cash costs these non-cash costs should not be forgotten.

BAUXITE Bauxite costs for the selected plants cover a range from $20 to $93 per tonne of alumina produced. The lowest cost is for a mine near to the plant where mining and transportation costs are low and there is no bauxite levy. The highest cost includes a high transportation cost and/or a high levy. Bauxite cost tends to be site specific and beyond noting the importance of proximity of the materials to the Plant site and of taxes, site dependence will not be elaborated.

ENERGY If there is such a thing as a typical alumina plant, it would consume about 12 million BTU per tonne of alumina produced. The type of fuel determines the level of energy cost more than the energy efficiency. The plant, having an energy source of hydroelectricity for steam generation and oil for calcination comes out at $23 per tonne alumina energy cost.

The plant which uses only oil and highly taxed has an energy cost at $81 per tonne of alumina.

LABOUR The labour costs depend on both the labour rates and the workforce required per annual tonne of alumina. Thus, the labour charges are low both for very large plants with high labour rates and the medium sized plants at locations with low labour rates.

Management skill, including the continual training and upgrading of personnel are tools for minimizing labour costs.

Labour in the plants studied showed a range from $11 to $50 per tonne of alumina.

CAUSTIC The caustic cost has a range of $3 to $53 per tonne in the Alumina plants studied. The main variants are price for caustic at the plant site, level of reactive silica in the bauxite and the capacity and efficiency of the soda recovery equipment and rate of reconversion of carbonate to caustic.

OTHER These are cash operating costs other than those mentioned above.

ALUMINA PLANT MANAGEMENT

As the manager of an Alumina plant you will most likely start with an existing plant where the initial decisions of location and size have already been made. Sources of raw materials (Bauxite, caustic, energy, spare parts etc.), markets and customer needs for quality (particle size, impurity levels etc.) already committed.

Even as the wide range of costs shown in Table I illustrates the contention that there are no typical costs for alumina production, it also presents some hope for reducing these costs.

BAUXITE Where mines are operated by the Alumina plants the cost of mining bauxite can be influenced by technological means. However, this is likely to have only negligible effect on the alumina costs short of massive capital charges.

Bauxite cost may also be reduced by improved extraction efficiencies but again the gains although needed are not large.

Where the bauxite costs include significant transportation and/or levy charges these cannot be reduced by technological means.

ENERGY Energy costs for a plant are made up of three components: the cost of generating steam for the process and generating electrical power or purchasing electrical power not generated with process steam and the cost of fuel to calcine alumina. Overall costs can be reduced in two ways - by reducing the amount of energy used, and by reducing the unit cost of energy.

The amount of steam used depends on liquor productivity (the amount of alumina produced by one unit of circulating plant liquor) since higher productivity with the same production rate requires less circulating liquor and hence less energy for heating and pumping liquor.

The other major component of energy cost is the energy used to calcine alumina.

There are three main types of calciners in use: the rotary kiln, the rotary kilns retrofitted to reduce energy consumption and the fluid bed calciner. These are in descending order of energy consumption. For the existing plants with rotary kilns retrofits seem the best choice.

Apart from reducing consumption, energy costs can be reduced by changing to cheaper forms of energy. The cost of energy from coal varies due to a number of factors, but is generally in the range of $1.50 - $2.50/million BTU or about one-half the cost of oil although the advantage over oil is reduced by the capital charge for a new steam generating plant and coal handling facilities.

Energy cost is one of the major variables of alumina production. The fuel type and cost are major factors. However, the cost savings by recovering energy from exit gases of alumina calciners and by improving liquor productivity can be appreciable. In general, an investment in energy management is well rewarded.

CAUSTIC Caustic cost depends on two things - the price paid for caustic soda, and the amount used. Technology can do little about the price. The amount used can be broken down into two components, one of which is caustic consumed by reactive silica in bauxite, which for a given bauxite supply cannot be reduced by plant techniques. The other component of caustic loss comprises losses from the mud washing circuit, physical loss and loss as impurity in product alumina.

SUMMARY

Some specifics for minimizing alumina production costs are summarized as follows:

PLANNING - The Alumina Plants have to be in the right place at the right time, with minimum construction times, followed by operation at rated capacities. Tax incentives and low interest loans ease the capital recovery charges.

RAW MATERIALS - Low cost energy and low cost bauxite are of paramount importance. Mineral benefication may upgrade the bauxite.

TECHNOLOGY - A modular plant design lowers engineering and expansion costs and economies of scale provide an incentive for few process trains.

High liquor productivity reduces investment and operating costs.

Conversion to alternate fuels may lower costs in existing plants.

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ALUMINA PLANT CAPACITIES

COUNTRY	COMPANY/PLANT			CAPACITY MT x 1000 YR
JAMAICA	ALCAN	:	KIRKVINE	550
			EWARTON	550
	JAMALCO	:	HALSE HALL	550-800
	ALPART	:	NAIN	1180
	REVERE	:	MAGGOTTY	200
SURINAME	SURALCO	:	PARANAM	1380
GUYANA	GUYBAU	:	LINDEN	350
AUSTRALIA	ALCOA	:	KWINANA	1400
		:	PINJARRA	2000-2400
		:	WAGERUP	500
	NABALCO	:	GOVE	1000-1100
	Q.A.L.			2400-2700
	WORSLEY			2400-2700

TABLE I

BREAKDOWN OF ALUMINA COSTS

	MINIMUM	MAXIMUM
BAUXITE	20	93
ENERGY	23	81
LABOUR	11	50
CAUSTIC	3	53
OTHER CASH COSTS	3	36
TOTAL CASH COSTS	60	313
CAPITAL CHARGE $1000/AT 4% DCFRR	70	100
$1500/AT 8% DCFRR	120	190

TABLE II

WORLD ALUMINA PRODUCTION

	(MTD x 1000)
INSTALLED CAPATICY	34,000
SMELTER DEMAND	25,000
OVERSUPPLY	9,000